



*Waves on the central Oregon coast.*

# Chapter 10 Navigation Improvements, 1912 to 1980

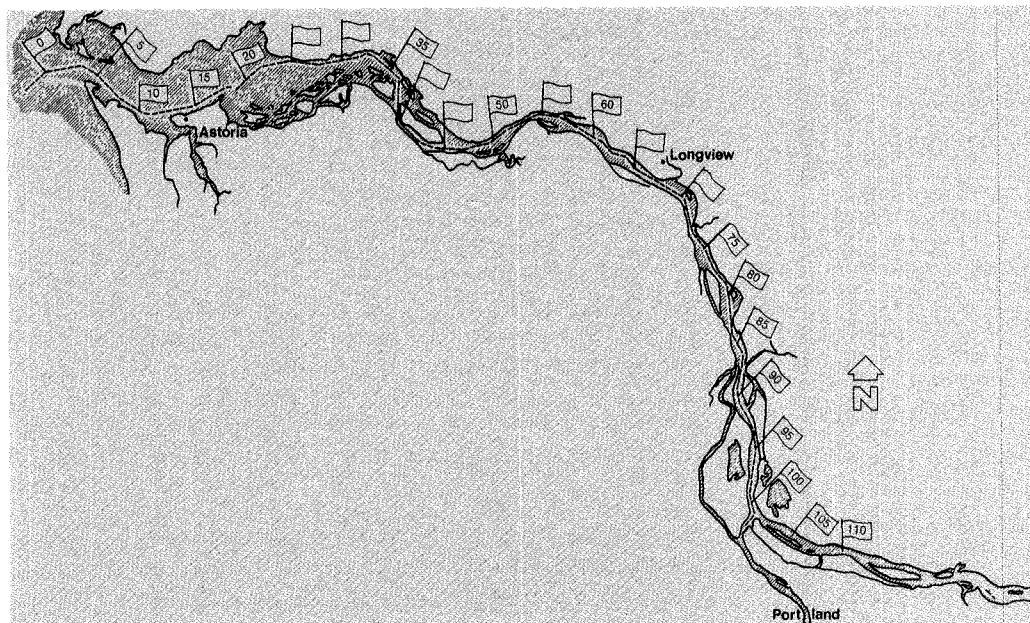
## Lower Columbia Ship Channel Improvements

Since 1871 the Portland District's constant mission has been the improvement of Northwest waterways for navigation. When the Corps began multiple-purpose projects on the Columbia and Willamette Rivers, it continued important work on the navigation channel from Portland to the sea and on the Oregon Coast. The background, justification, and benefits of these projects all show the direct relationship between the work of the Portland District and the economy of the region which it serves.

Good transportation facilities remained vital to the economy of the Pacific Northwest. Located in a distant corner of the United States, the Northwest is far from the largest markets and producing areas of the rest of the nation. As a result, the cost of transportation often made Northwest-produced goods uncompetitive with goods in other regions, while raising the price of imports to the region. The great mountains which ring the Pacific Northwest made interregional highway and railroad construction more costly than in other parts of the United States. In terms both of the value and the type of cargo, waterborne commerce capacity constituted an essential asset of the Pacific Northwest.

Three projects—in 1930, 1954, and 1962—served as the basis of the renewed Portland ship channel work. The last major Portland channel improvement had occurred in 1912. It provided for a navigation passage 30 feet deep and 300 feet wide, from Portland Harbor to the sea. Wheat, flour, lumber, and barley constituted the main exports at Portland before work commenced on the 30-foot channel. Cement, coal, and rice were the principal imports. Petroleum product imports became increasingly important after the completion of the 30-foot channel in 1918.<sup>1</sup> From 1871 to 1918, total tonnage, imported and exported, had increased from 147,000 tons annually to about 2,000,000.

The Portland District undertook four significant projects on the Columbia below Vancouver, Washington, between 1912 and 1930. The first resulted from the additional shipping to Vancouver required by the World War I construction and training activities at the army's Vancouver Barracks. The River and Harbor Act of 1892 had authorized the original improvement of the four-mile stretch of the Columbia between Vancouver and the mouth of the Willamette. After a survey in 1891, Major Handbury reported that a sand bar obstructed navigation by deep-draft vessels. He proposed to remove the shoal and obtain a 20-foot depth by increasing the flow in the main channel on the north side of Hayden Island. A 3,000-foot brush and stone pile dike from the Oregon shore to the head of the island accomplished this by closing the chute behind the island. The project also included



Map of the Columbia River from Portland to the mouth.

*Puget Island in the Lower  
Columbia River.*



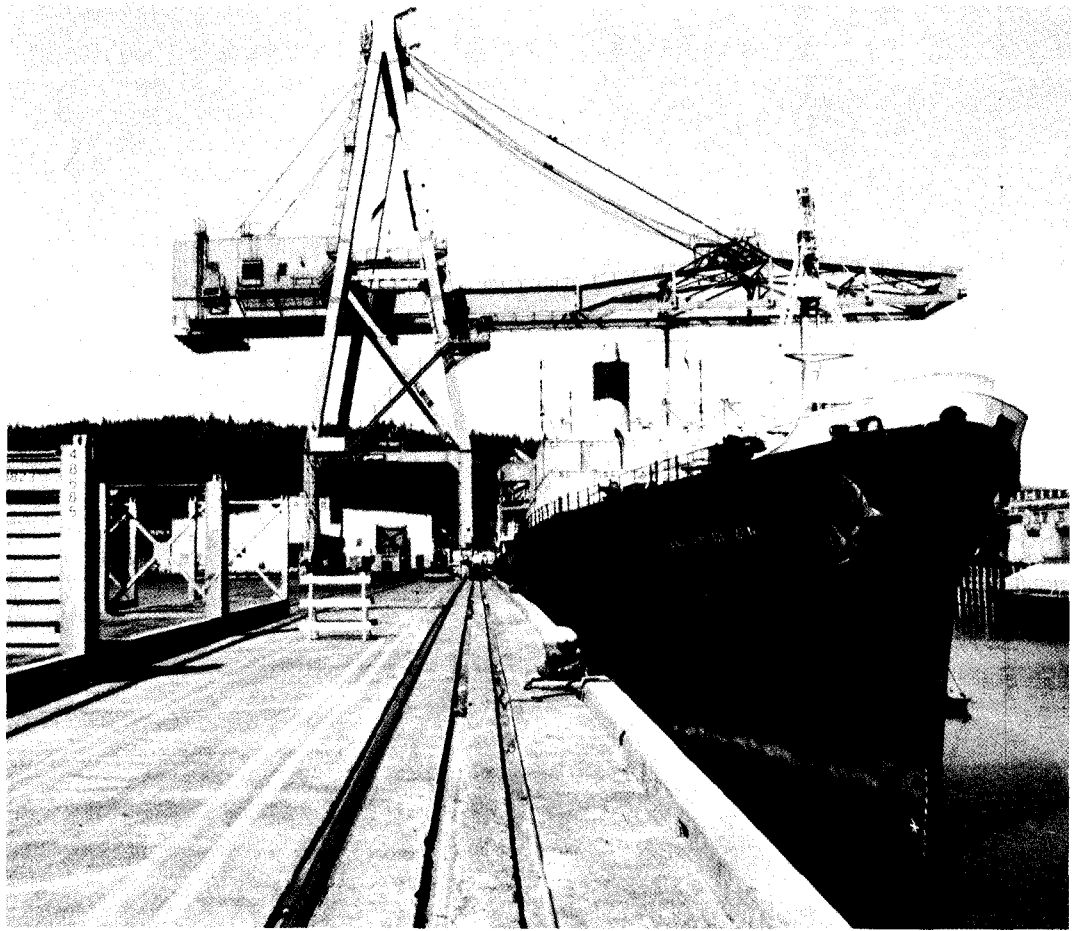
revetment work at both ends of the dike. The project proved inadequate, and in 1905 the Portland District began annual dredging to maintain the 20-foot depth.<sup>2</sup>

In 1916, the River and Harbor Act included the Columbia River between Vancouver and the mouth of the Willamette River in the Portland-to-the-sea project. As a result, the Portland District maintained by dredging 20-foot depths and a 200-foot width in this section of the river. Lumber constituted the principal export from Vancouver, and the growing demands of this trade led to further improvements. In 1925, Congress authorized a channel 25 feet deep and 300 feet wide. Local interests paid for the initial work and the Corps assumed the annual maintenance costs.<sup>3</sup>

The second lower Columbia project called for improvements at Cathlamet Channel, on the Washington side of Puget Island about 40 miles from the mouth of the Columbia River. After a preliminary examination in 1912, District Engineer Major James F. McIndoe reported that "the largest industries in the vicinity, and practically the only ones, are logging, fishing and dairying." He further noted that timber reserves in the area were "about four to five billion board feet in extent, lying mostly in the drainage basin of the Elochoman River." He found the channel greatly obstructed by snags and an eight-foot shoal at the downstream entrance. Depths were undependable and hazardous even for riverboats (deep-draft vessels operated on the south side of Puget Island in the Columbia River), particularly so in fog or stormy weather. While not agreeing with local interests that the channel should be deepened to accommodate ocean vessels, McIndoe did recommend improvements to assist the local commerce carried by river steamers. McIndoe estimated that \$15 million worth of freight passed through the channel annually. In 1917, Congress authorized his project to remove snags and to maintain safe water in Cathlamet Channel 10 feet deep and 300 feet wide.<sup>4</sup>

The third Corps project involved cutting a 1.5-mile channel from St. Helens, Oregon to the 30-foot channel in the Columbia River. St. Helens, located at mile 86 on the Columbia River at the head of Willamette Slough, was separated from deep water in the Columbia by a 19-foot bar. In 1921, Major Robert Park, Portland District Engineer, reported that St. Helens, the chief port between Portland and Astoria, had four large lumber mills and a creosote plant, generating waterborne commerce of about 180,000 tons annually. He proposed, and Congress authorized in 1923, a connection channel 25 feet deep and 300 feet wide at a cost of \$3,600 for new work and \$2,000 for annual maintenance.<sup>5</sup>

The fourth project, undertaken in 1927, comprised channel alterations in the Portland harbor approved by the Corps of Engineers but carried out by the Port of Portland. As early as 1876, Major Wilson had advocated closing the narrow but deep north channel at Swan Island and improving the wide but shallow south one for navigation. However, on the grounds of cost and disruption to commerce, a board of engineers disapproved the proposal. In 1890, Major Handbury took another look at the situation but deferred judgment while he concentrated on preparing the project for a 25-foot channel to the sea. Finally, the Port of Portland in 1899 received permission to dredge a 35 by 1,550-foot channel on the south side of the island and in 1927 requested authority to permanently close the north channel. The district engineer now agreed "that the closing of the upper end of the east [north] channel is in the interests of navigation and general harbor development and should not injuriously affect the regimen of the river." Since the Port of Portland maintained



*Freight loading at Swan Island in Portland's harbor*

the Willamette River portion of the Portland-to-the-sea project, the Port carried out the closure at its own expense.<sup>6</sup>

From the completion of the 30-foot channel in 1918 to 1929, ocean-going cargo through Portland had more than tripled to 6.9 million tons. Total value of the cargo had quadrupled to \$338 million. As impressive as that growth appeared, the existing 30-foot depth and 300-foot width greatly restricted further improvements in shipping. At that time, trans-Pacific liners with full-load drafts of 30 feet or over carried almost 90 percent of the higher-valued package freight. These ships could not reach Portland fully loaded. Imports of this type ultimately destined for Portland had to come on coastwise vessels from Puget Sound or San Francisco, or required lightering to smaller craft at Astoria.<sup>7</sup>

Since the fixed costs of a vessel had to be matched against a smaller payload, shipping on smaller vessels or on larger ships only partly loaded produced higher costs. The restriction to smaller, slower freighters also greatly hindered the development of foreign trade at Portland. Deep-water ports up and down the Pacific Coast recorded rapid increases in visits by vessels of 30 to 33-foot draft.

The grounding of some ships pointed out another problem on the Columbia. During 1925, 37 ships suffered such accidents. This danger stemmed not so much from the shallow depths as from the narrow channel. Busy traffic on the river sometimes crowded a ship out of the channel. Longer vessels had difficulty passing other ships and turning. Many owners would not allow their ships to navigate at night on the Columbia for fear of damage and delay resulting from grounding, but anchoring in a narrow channel at night was equally risky. High insurance rates as well as increased shipping costs reflected the fear of grounding.<sup>8</sup>

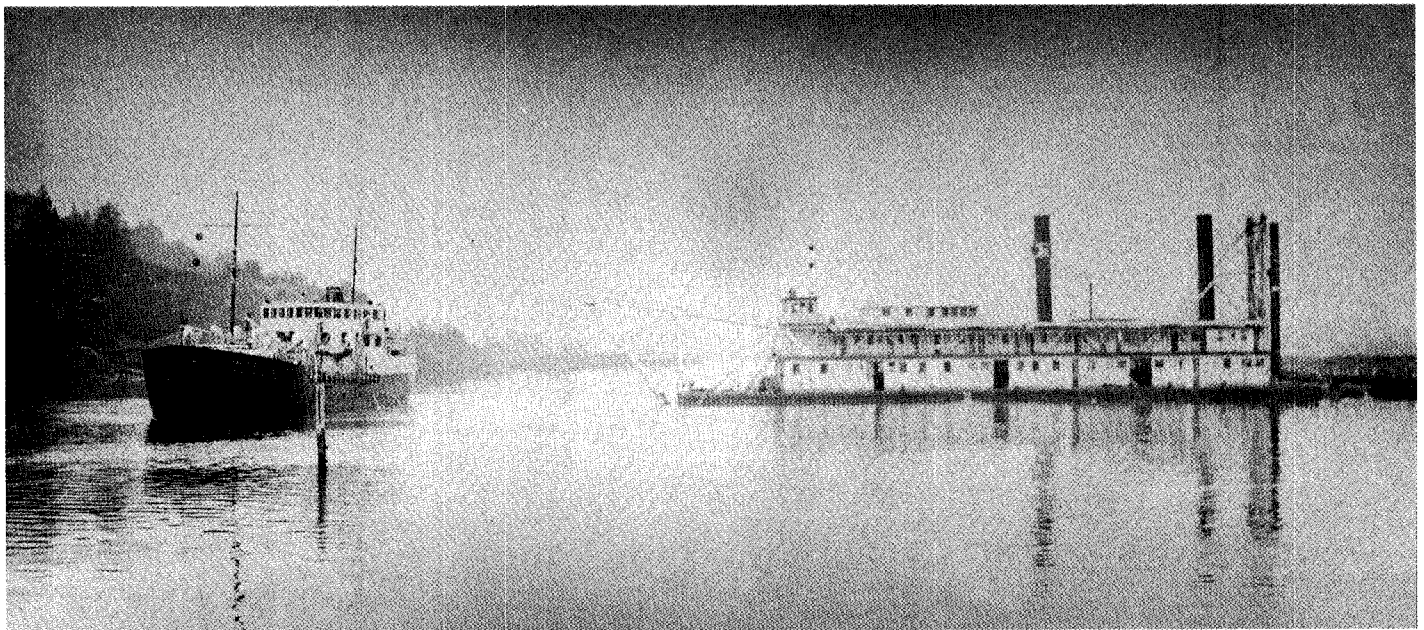
Based on these conditions, District Engineer Major Richard Coiner recommended dredging and placing permeable dikes to establish a 35-by-500-foot channel from Portland to the sea. The engineers designed the contraction works to maintain the channel depths once dredging had created them. Experience demonstrated that as dredging progressed and spoil banks filled in between the dikes, a permanent and stable channel resulted. This decreased the amount of annual dredging necessary to hold project depths. Coiner estimated the initial cost of the project at \$1,366,000 with annual maintenance set at \$685,000. He also projected annual savings to shipping from the improvement at \$609,000.<sup>9</sup>

The Port of Portland had responsibility for obtaining and maintaining project depths in the Willamette River from its mouth to the Broadway Bridge in Portland's harbor and

for dredging the shoal just outside the mouth. The Port also agreed to provide the Portland District six dredging months annually during the critical period following spring freshets in the Columbia at no charge except operating costs. The Port made available its two hydraulic pipeline dredges for this work. The Corps and the Port began the project in 1931 and completed it in 1933. The U.S. dredges *Multnomah*, *Wahkiakum*, and *Clatsop* carried out the Portland District's share of the initial work and a total of 130 spur dikes stabilized the results.<sup>10</sup>

The project provision requiring the Port of Portland to maintain the 35-foot depth in the Willamette River became an intolerable burden for the organization. Up to 1933, the Port of Portland spent \$13 million on improving the ship channel to the sea. Now, Depression-era financial pressures prevented the Port from carrying on this responsibility. In fact, the district engineer reported in 1933 that for the past three years the Port had performed little channel maintenance, allowing 5.6 million cubic yards of material to build up in the harbor. This accumulation represented three to six years worth of silt that needed immediate removal to restore the project depth. Local interests requested that the federal government assume the task of maintenance-dredging in the Willamette. After careful deliberation, Major Kuentz recommended that "in view of the importance of Portland as a world port, and of the large contributions by local interests in defraying the cost of work that is beneficial to the general public, it appears that the port should be relieved of further expense for work of this class." In 1935, Congress agreed and assigned the maintenance chore to the Portland District. The Port remained obliged to provide six months of

*below: Corps of Engineer  
pipeline dredge and hopper  
dredge working at the  
Willamette River mouth.*



hydraulic dredge time, to assist on the maintenance work "when required," and to furnish free of charge areas for disposal of dredged material.<sup>11</sup>

The Portland District also performed several smaller but noteworthy projects between the completion of the 35-foot channel in 1933 and improvement of the entrance at the mouth of the Columbia in 1954. Provisions in the River and Harbor Acts of 1935 and 1937 authorized navigation improvements permitting a channel 30 feet deep and 300 feet wide from Vancouver to the mouth of the Willamette River. The district also dredged at Vancouver two turning basins, 30 feet deep, 300 feet wide, and 2,000 and 3,000 feet long for the upper and lower basins, respectively. The construction of new terminal facilities by local interests in Vancouver made this work necessary.<sup>12</sup>

In 1937, Congress authorized navigation improvements upstream from Vancouver. This work provided for a channel 27 feet deep and 300 feet wide between Vancouver, Washington, and The Dalles, Oregon, a distance of about 85 miles. The legislation for the 27-foot channel was prompted by the desire to take advantage of the lock at Bonneville Dam and the slackwater pool behind it. Items subsequently incorporated in this project included a channel 10 feet deep and 300 feet wide at the upstream entrance of the Oregon Slough; a suitable turning basin in the vicinity of Camas and Washougal, Washington; a boat basin at Hood River, 10 feet deep, 200 to 450 feet wide and 1,300 feet long, with a connecting channel 10 feet deep, and breakwater on the easterly side; a barge channel to Bingen, Washington, 10 feet deep, 150 to 300 feet wide, and about 1,800 feet long; and a harbor at The Dalles, including a breakwater and a basin 8 feet deep, 400 feet wide and 800

feet long. Project dredging and contraction works cost nearly \$6 million. The Portland District allowed the channel depth to fill to 15 feet after 1959 because the shallow-draft barges using the river did not require more. In order to lessen the number of times that the drawspan on the Interstate Bridge between Vancouver and Portland needed raising for small craft, the District completed a separate channel (15 feet deep and 300 feet wide) under the fixed portion of the span. The Corps finished all of the projects on the Columbia River between Vancouver and The Dalles by 1963. Between 1968 and 1977, the annual traffic over this section averaged 5.9 million tons.<sup>13</sup>

The Portland District undertook two projects near the mouth of the Columbia River on the Washington side in 1933 and 1938 to benefit the important fishing trade at this location. At the northwest end of Baker Bay sits the fishing town of Ilwaco, Washington. In 1933, the Federal Emergency Administration of Public Works funded a Corps project for a channel 10 feet deep and 200 feet wide from Ilwaco through the easterly passage at Sand Island to deep water in the Columbia River five miles away. The Corps also constructed a 20-acre, 12-foot deep mooring basin with a breakwater. The engineers dredged another channel 10 by 200 feet and three miles long from Ilwaco through the westerly passage of Sand Island to the Columbia. The Portland District completed the large east channel in one year; but the remaining work, as modified by the river and harbor acts of 1945 and 1950, was not finished until 1957 at a total cost of \$1.2 million.<sup>14</sup>

Chinook, a small fishing town in the east end of Baker Bay about ten miles from Ilwaco, also received work by the Corps. In 1938, Congress authorized a channel 10 feet deep and 150 feet wide from the head of Sand Island to Chinook, a small turning basin, and reconstruction and extension of a breakwater built previously by private interests. The District finished the original project in 1940 and carried out modifications between 1958 and 1962. Total cost of the work came to \$448,000.<sup>15</sup>

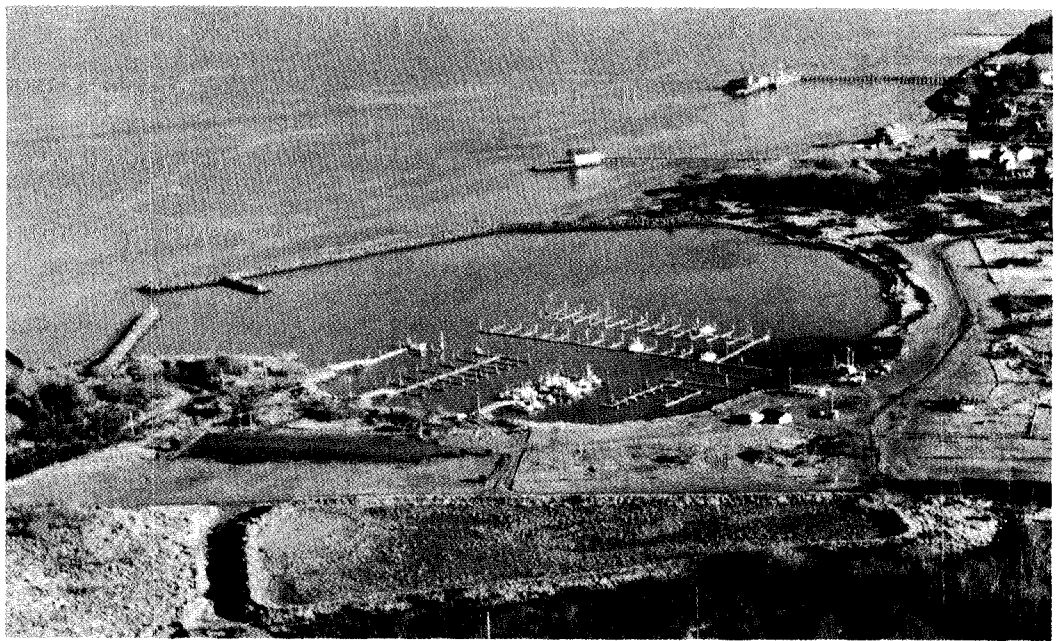
Other lower Columbia projects completed prior to World War II consisted of deepening auxiliary channels at the towns of St. Helens and Rainier, Oregon; at the Skipanon and Clatskanie Rivers; at Youngs Bay, Westport and Oregon Sloughs, and at the Multnomah Channel of the Willamette River. These small projects facilitated waterborne traffic to and from the main channel at various points between Astoria and Portland.<sup>16</sup>

At the end of the war, the District began three small projects, two of which were located at Longview, Washington. Longview's principal industry consisted of wood products, with average annual log movement on water in the early 1940s of over 310 million board feet. Five to six large rafts were towed to the mills daily. To facilitate these deliveries, Congress authorized in 1945 deepening two secondary channels, connecting the lumber mills with the main ship passage on the Columbia. The District completed the improvements over a five-year period.<sup>17</sup>

The third minor project undertaken after World War II was a small boat mooring basin at Astoria, authorized in 1946. At this time Astoria functioned as the most important fishing port in the Pacific Northwest. Local fishermen brought in 68 million pounds of fish in 1944—more than at any other Northwest port. Astoria produced the largest amount of frozen and processed bottom fish on the Pacific coast. Resident and transient fishermen participating in this catch, as well as over 1,500 visiting pleasure craft annually, would greatly



*Ilwaco boat basin*



*Hammond boat basin at  
Astoria.*

benefit from construction of an improved small boat mooring basin. Such interests pressed for a mooring basin which would at least double the existing capacity of 400 vessels. The adopted project called for a steel pile, sand-filled breakwater about 2,400 feet long with a 20-foot maintenance roadway running along its entire length, and two steel pile shore wings totaling 1,460 feet in length. The District completed the basin with provisions for 1,000 small boats in September 1950.<sup>18</sup>

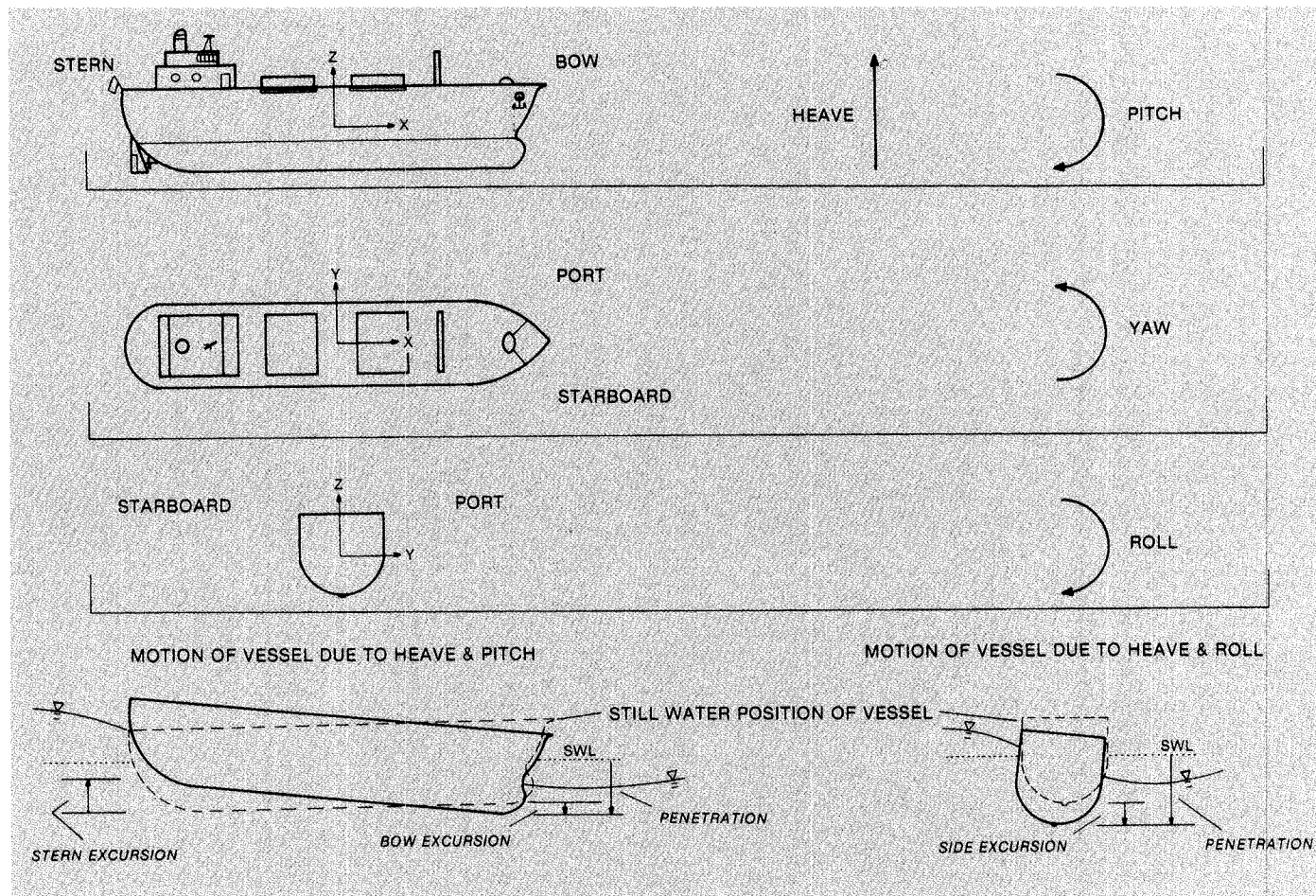
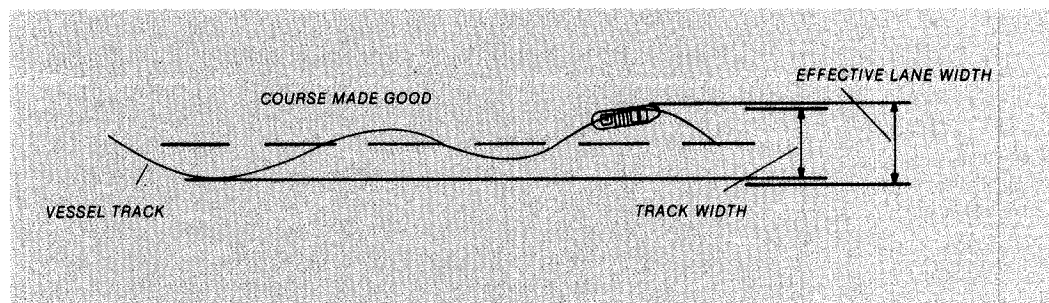
From 1940 to 1950 the population of the Pacific Northwest increased rapidly. Oregon grew 39.6 percent, and Washington 37 percent compared with the national rate of 14 percent. In 1905, oceanborne commerce over the lower Columbia River amounted to 940,000 tons. By 1950 oceanborne commerce had increased nearly tenfold to 9.2 million tons per year. Traffic above The Dalles reached one million tons a year, and above Willamette Falls Locks two million tons in rafted logs and barge traffic. Domestic trade accounted for nearly all of the increase on the Columbia. Better conditions at the mouth would also have greatly improved foreign trade. In 1952, 40 ship lines served the lower Columbia River, offering service to and from the major ports of the world. Ten lines provided regular intra-coastal and Gulf of Mexico service. Several lines specialized in lumber or cement, and eight major oil companies brought petroleum products in T-2 class tankers. By the early 1950s six port associations existed on the lower Columbia: Portland, Astoria, and St. Helens in Oregon, and Vancouver, Kalama, and Longview in Washington. These ports had invested over \$60 million in terminal and dock facilities. The rapid growth in shipping and commerce on the lower Columbia coupled with deteriorating conditions at the mouth of the river sparked demands for improvements.<sup>19</sup>

On 10 March 1949, District Engineer Colonel Orville E. Walsh conducted a hearing in Astoria to consider the merits of improving the entrance at the mouth of the Columbia River to a depth of 48 feet. Bar pilots, shipping operators, port commissioners, manufacturers, fishery and agricultural interests, governmental agencies, chambers of commerce, and river pilot representatives unanimously stated the need for improving the mouth of the Columbia. The size of post-war ships had outdistanced the existing improvements of the ship channel.<sup>20</sup>

The previous project had provided a depth of at least 40 feet in the channel across the entrance bar, secured by jetties and dredging. Congress had authorized this depth in 1905 and the Portland District had achieved it in 1917. Subsequently, the outer portions of the north and south jetties had been subject to heavy wave action and gradual disintegration. The Corps rehabilitated them in 1938-1939 and 1941, placing concrete terminal blocks at their outer ends. Annual maintenance included strengthening and repairing existing structures, repairing sand fences to prevent erosion, mending pile dikes to influence river and tidal flow, dredging the northwest shore off Clatsop Spit, and maintaining Sand Island to protect the inner reach of the entrance. Maintenance costs averaged about \$214,000 each year for the five years before 1953.<sup>21</sup>

Regular maintenance, however, could not keep up with the increased rate of channel deterioration at the mouth. From 1926 to 1941, the channel across the outer bar had a minimum depth of 46 feet. By 1944 the bar had shoaled to 44 feet. In 1951 the least depth in the channel was 42 to 43 feet. In addition to the shoaling, the western and northern sectors

below and right: Diagrams showing movements of vessels underway in a river channel.



of the outer bar had deepened, no longer affording protection to the channel. Moreover, the constant advance of Clatsop Spit into the channel between the jetties made the turning angle in the channel sharper and more dangerous. These changes combined with rough seas to make bar crossings hazardous in stormy weather.<sup>22</sup>

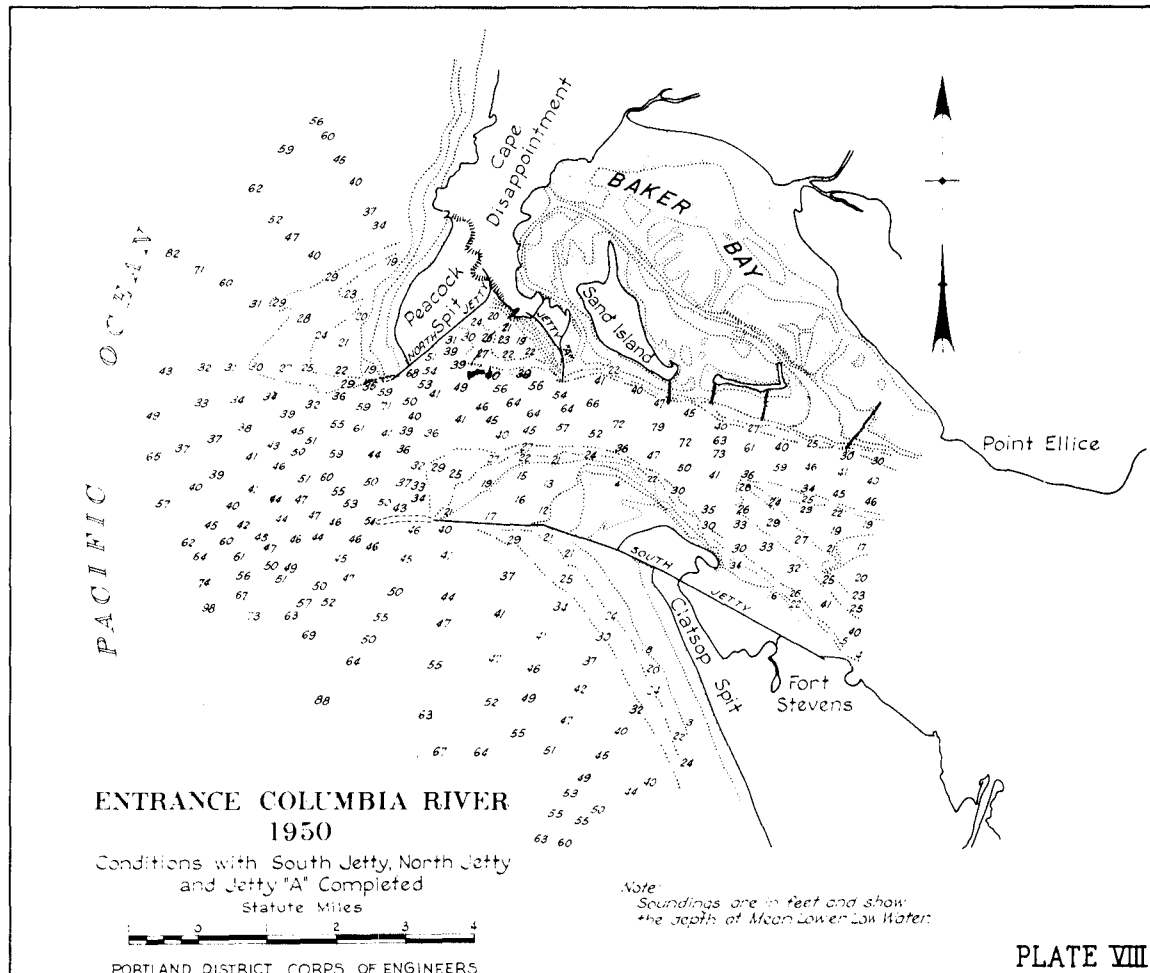
In rough seas a ship develops a tremendous pitch, known as "sounding." The weight of a large vessel diving into a low trough in the sea presents a different problem of drafts and safe channels than does a smaller ship on calm river water. When storm waves are running, vessels may strike bottom in depths exceeding their draft by 15 feet or more. Oregon and Washington seas are notoriously rough; during the later 1940s and early 1950s many larger vessels reported striking bottom when sounding. In stormy weather, ships of 28 to 33-foot drafts found it unwise to enter the 41-foot deep Columbia River; for experience showed that ships needed 15 extra feet as a minimal safety margin in bad conditions. Maritime underwriters would be very likely to restrict travel by large ships through the entrance if it were to remain in a dangerous condition. The steady increase in ship capacity pointed up the problem. In 1925, four ships of 30-foot drafts or deeper had crossed the bar. In 1946, there were 46, and in 1950 there were 398. Ships crossing the bar at the mouth of the Columbia in the early 1950s carried about twice as much cargo (2,818 tons on the average) as did ships in 1925 and four times as much as when the 40-foot project was authorized in 1905. Most of the larger vessels were tankers.<sup>23</sup>

Oil companies operating large tankers loaded their ships for less than full draft for Columbia River delivery in order to provide a greater margin of safety. Of 112 voyages

made in a typical year, 100 were loaded to 9 inches less than full draft and 12 filled to 7 inches less than full draft. Each inch on these ships represented 67 to 70 tons of cargo, amounting to 66,000 tons less than full capacity.<sup>24</sup>

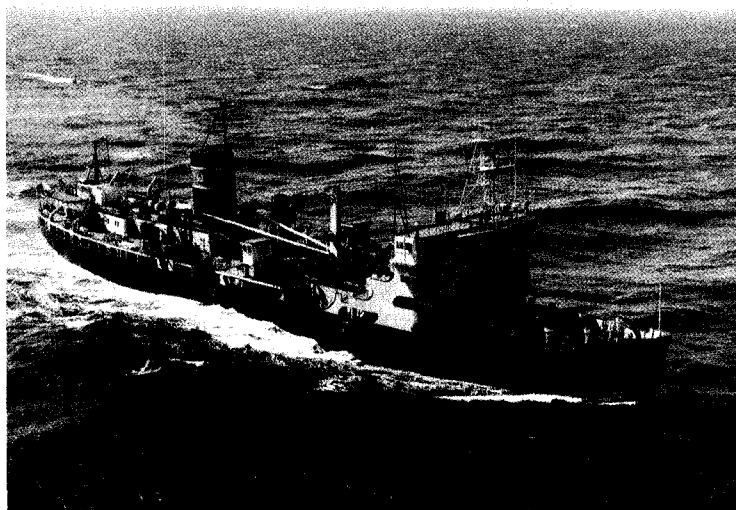
The unsafe entrance at the mouth of the Columbia created other problems besides less-than-capacity loads. Wasteful delays proved a common occurrence at the mouth. When a deep draft vessel encountered stormy conditions, the bar pilots usually advised waiting for better weather and a safer crossing. The cost for "lay" time for general cargo carriers ranged at this time from \$50 to \$125 per hour. The same cost to a tankship averaged about \$101 per hour. Of course these delays drove up rates and prices.<sup>25</sup>

The *Drexel Victory* grounded in stormy conditions on 20 January 1947, cracked amidship, broke into two parts shortly after grounding, drifted to sea, and sank. No lives



above: Chart showing 1950 survey of the Columbia River entrance.

right: The hopper dredge Biddle working at the mouth of the Columbia River.



were lost but the ship and cargo, valued at \$2.25 million were total losses. In the early 1950s, annual grounding losses averaged about \$200,000, excluding operating costs.

To prevent the worsening of navigational conditions and to lay the basis for future trade gains, the Portland District Engineer, Colonel T. H. Lipscomb, proposed an \$8.5 million project to establish and maintain an entrance channel 48 feet deep and one-half mile wide. Congress adopted the project in the River and Harbor Act of September 1954. The appropriation included \$2.9 million for initial dredging and \$5.7 million for construction of a one-mile spur jetty on the north shore which would extend from Cape Disappointment on the inside of the north jetty and roughly parallel to it.

The Portland District started dredging the 48-foot bar channel in April 1956 and completed it in September 1957. The Corps removed almost 17.5 million cubic yards of material to complete that part of the project. The entrance work extended five miles in length, reaching two miles seaward and three miles landward from the outer ends of the jetties. Initial operations showed that the material could be removed more cheaply by annual dredging than by the effect of the proposed spur jetty, so it was never built. Annual dredging costs turned out less than the projected annual amortization rate of a spur jetty. Dredging between the original north and south jetties and building pile dikes at Sand Island provided project depths. The Corps rehabilitated the south jetty from 1962 to 1964 and repaired the north jetty and pile dikes in 1967. On the average, 3.5 million cubic yards of material must be removed by hopper dredge each year to keep the entrance channel at the 48-foot depth.<sup>28</sup>

As soon as local interests succeeded in getting the Corps to improve the entrance of the Columbia, they began lobbying for a deeper ship channel to Portland. Their goal was a 40-foot deep, 750-foot wide navigation channel from Portland to the sea. This constituted an increase of five feet in depth and 250 feet in width over the existing project adopted in 1930. As the Port of Portland pointed out, the same problems that plagued the mouth of the Columbia before its improvement, continued to affect adversely the ship channel. The rapid post-war increase in deep draft vessels calling on Portland—1 out of 4 inbound movements by 1958—underlined the inadequacy of the narrow 35-foot channel. Restrictions on vessel movement, arrival and departure delays, and marine casualties presented a continuing threat under existing conditions. This situation created ominous questions for future traffic growth in the lower Columbia. Certainly the economic stakes were high.<sup>29</sup>

Immediately after World War II, shipping on the lower Columbia totalled about 15 million tons per year. This included rafted logs and through traffic (cargo originating outside the project which passed through for destinations beyond the project). By the time the 40-foot channel became seriously discussed in the early 1950s, total tonnage had passed the 20 million ton per year level. Of the roughly 20.6 million cargo tons in 1959, nearly 33 percent comprised imports of petroleum products; almost 20 percent represented foreign exports of grain; about 22 percent included log shipments; 10 percent made up forest products; and about 8 percent consisted of sand, gravel, and crushed rock. Total value of the cargo came to \$510 million.<sup>30</sup>

In 1957, the Committees on Public Works of the United States Senate and House of Representatives directed the Corps to determine the advisability of modifying the navigation project on the lower Columbia River to provide larger dimensions. After several years of study and consultation with the states of Oregon and Washington and various federal agencies, the Portland District Engineer, Colonel Sterling Eisinger, issued a report calling for a 40-foot deep, 600-foot wide navigation channel from Portland to the sea. While concurring in the basic findings and recommendations of the district engineer, the division engineer and the Board of Engineers for Rivers and Harbors agreed that the report overstated the project's economic benefits and understated its costs. They felt a more realistic benefit-to-cost ratio was 1.5 instead of 1.6 to 1.0. At an estimated cost of \$20,000,000, the Portland District proposed undertaking its most expensive navigation project ever.<sup>31</sup>

According to Colonel Eisinger, increased vessel size justified the costly 40-foot improvement. Tankers built during World War II had 16,000 deadweight tons, 68-foot beam, 523-foot length, and 30-foot draft measurements. Because of economies enjoyed by larger vessels and their 20 to 25 year life, many operators in the late 1950s began building much larger tankers to replace their T-2's. These new supertankers were twice as heavy, up to 25 feet wider, 100 feet longer, and with drafts 3 to 6.5 feet greater. Tankers of this size could not navigate in the 35-foot deep, 500-foot wide channel of the lower Columbia River. Studies predicted that even larger tankers would be in use by the 1960s. Unless the Columbia River channel were improved, the older, smaller, less economical ships would have to serve the area.<sup>32</sup>

Economies and demand-growth factors similar to those which stimulated tanker development after World War II also encouraged expansion of dry-bulk carriers. Minerals made up the principal cargoes of these vessels and the depletion of high-quality domestic mineral reserves spurred the discovery of sources far from manufacturing and consuming centers as in the case of the aluminum industry which developed deposits in the West Indies,

Surinam, and Japan. Huge dry-bulk carriers linked the source of raw materials with the consuming center.

The United States fleet had 49 dry-bulk carriers in 1959 and these were usually smaller than tankers. Dry-bulk carriers averaged 13,980 deadweight tons (d.w.t.) while tankers averaged 19,700 tons. Existing dry-bulk carriers also had a smaller draft than tankers. However, in 1955 the United States Maritime Administration prepared a prototype design of a typical bulk carrier for future American fleets. The proposed vessel, with 24,000 d.w.t. and a draft of 33 feet, resembled many dry-bulk carriers then being constructed in European shipyards. Such a ship would be unable to navigate the 35-foot channel in the Columbia River.<sup>33</sup>

Several factors beyond a ship's design draft and beam determine safe navigable water. A 16,000 d.w.t. ship underway at ten knots will sink two to five inches at the bow and about two feet at the stern. This phenomenon is called "squat." The greater the size and speed of the vessel, the greater the squat. "Drag" results from loading a ship more heavily at the stern to obtain better handling. Inbound tankers will average 15 inches, and outbound wheat vessels average about 20 inches drag. "Sinkage" is the effect upon a ship when entering fresh water from salt water. In the Columbia River this amounts to one-fourth inch per foot of draft, or a range of about six to nine inches. Finally, two to three feet of clearance is essential for safe steerage which depends upon the weather, the size of the ship, the pilot, and the river conditions. The combination of these factors results in the need for a channel five to six feet deeper than the draft of the largest existing ships using the Columbia River. A 40-foot channel would provide safe passage for ships of 30,000 to 33,000 d.w.t. and 34 to 35-foot drafts. Larger vessels could operate in good weather with modified load and speed factors.

Ship operators and river pilots also need adequate channel width, since a vessel changes course 106 times in the 100 mile transit from Astoria to Portland. Because of bank suction, ships require greater width when passing in restricted river channels than in open water. The propeller action of a large vessel close to the side of the channel will suck water out of the space between the ship and side of the channel, and the ship will naturally move to the area of least water resistance. Cross currents, anchoring requirements, and weather conditions also help determine the safe width for the channel. A 600-foot-wide channel would provide more than adequate passage for old Liberty, Victory, C-3, C-4, and T-2 vessels, eliminating the hazards and delays threatened by the older channel. All of the newer ships, using care, could pass safely in such a channel.<sup>34</sup>

The large Pacific Northwest aluminum industry would also benefit from the improved navigation on the Columbia River. Attracted by cheap hydroelectric power, the aluminum industry opened its first Northwest plant in 1940 and expanded throughout the region during the war years. After a post-war downturn, the industry experienced a resurgence in the years of the Korean War. In the late 1950s, problems once again clouded the industry's future. Availability of cheap natural gas on the Gulf coast, recurrent shortages of hydroelectric power in the Northwest, and railroad freight rate increases all tended to place the region in a less competitive position with the Gulf coast or the Ohio valley. Improved navigation of the Columbia, lowering the transportation costs of importing bauxite to the region would aid the Northwest aluminum firms.<sup>35</sup>

The increasing size of ships, the promise of greater use of the river, and the benefit to industrial expansion prompted adoption of the project. In the River and Harbor Act of October 1962, Congress called for a channel 40 feet deep and 600 feet wide from Vancouver, Washington to the mouth of the Columbia River and from the Broadway Bridge in Portland to the mouth of the Willamette River. Widths in the Willamette ranged from 600 feet to 1,900 feet to accommodate movements in Portland's harbor. The Act provided enlarged turning basins for Vancouver and Longview, Washington.<sup>36</sup>

The project also called for additional pile dike construction. Pile dikes, permeable groins of timber and stone, extended into the river and helped maintain the navigation channel. They concentrated the flow of the river in the channel, producing a natural



*Pile dike on the lower  
Columbia River.*

right: Pile dike construction.  
far right: River end of typical  
pile dike.



scouring effect and stabilizing the bank lines. The dikes also provided areas for disposing of dredge spoils.

The Portland District had initiated pile dike construction in the lower Columbia River in 1885 at St. Helens Bar, increasing natural depths of 15 feet in the main channel to 25 feet. The engineers had constructed other early dikes at Martin Island Bar and Walker Island Bar in 1892 and 1893 but built most of the present-day pile dike system in the periods 1917-23 and 1933-39. By 1961, 159 pile dikes totaling 148,400 linear feet lined the ship channel. Much of the old dike system had become sanded in or buried under material dredged from the river. The Corps planned 29 additional dikes and extensions of 14 older ones, amounting to 19,600 feet of new construction. The engineers located the dikes to insure that maintenance of the channel would provide project dimensions on a year-around basis, eliminating the need for several millions of dollars of dredge work each year.<sup>37</sup>

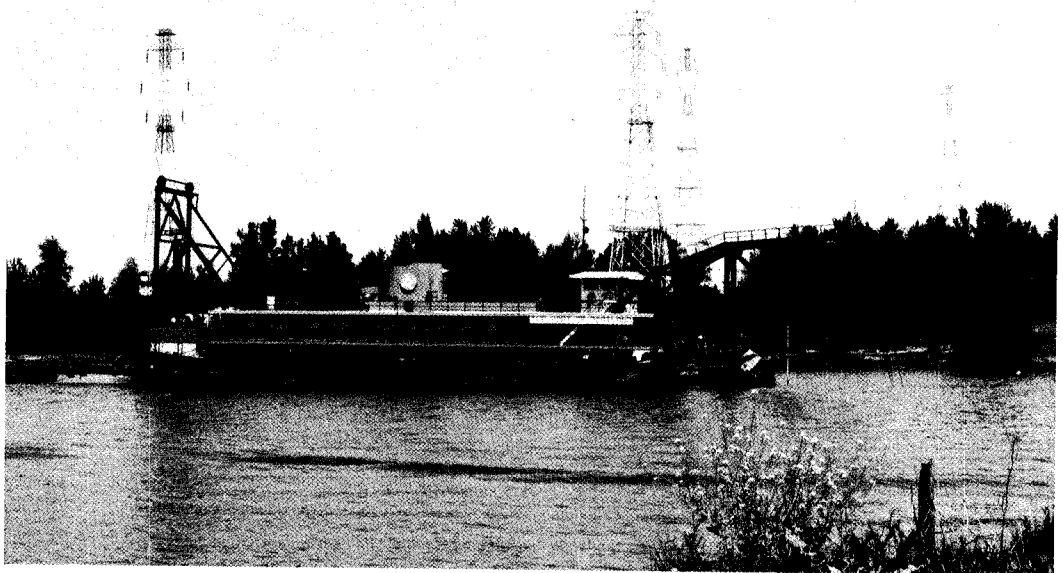
The project required extensive local cooperation. The port districts on the lower Columbia had to provide land and right-of-way for the improvement, including spoil-disposal areas from the dredging and locations for the retaining dikes, bulkheads, and embankments. Local interests had responsibility for all necessary alterations to sewage works, cables, water supply, drainage, and other utility facilities. The port districts also had to provide public terminal and transfer facilities with adequate depths in berthing areas and access channels open to all on equal terms. The United States would be held free from damages caused by the project. The Port of Portland had to make a lump-sum payment of \$369,000 for land enhanced by the improvement. Until local interests gave firm legal and financial commitments to the project, no work could begin. As an essential element of local cooperation, the Port of Portland supplied dredging assistance. The Port made available a pipeline dredge in good operating condition, with full crew and equipment, to the Portland District without charge except operating costs. The Port's huge pipeline dredge, *Oregon*, worked on the 40-foot project about six months each year.<sup>38</sup>

The improvement finally got underway in 1964. Using hydraulic models, the engineers placed the pile dikes and spoil-disposal areas in locations least disruptive of the commercial fishery on the lower Columbia and still acceptable to port officials and local property owners. The Corps planned to complete the project in four years, but small Congressional appropriations prevented this. By 1969, the Corps had finished only 54 percent of the improvement. Both Corps-owned and contract dredges performed the new and maintenance work.<sup>39</sup>

The Portland District experienced further delays on the project in the early 1970s. The Corps now had to prepare environmental impact statements for proposed channel work. The district halted all new construction in March 1973 while it prepared the environmental study. The federal and state resource agencies' responses to the draft EIS indicated concerns that the Corps had not adequately dealt with the fishery and environmental problems related to river channelization and to long-range disposal of dredge spoils, but no legal challenges arose. Prior to release of the final EIS in July 1975, the district awarded the final project contracts. These required rock removal from the Portland Harbor and Columbia River.<sup>40</sup>

The Portland District completed the 40-foot project in 1976 at a cost of \$23 million. On August 21, the district held a dedication ceremony at Kelley Point Park in Portland, at

*Port of Portland pipeline  
dredge Oregon working in  
Portland harbor*



## **Oregon Coast Improvements**

the confluence of the Columbia and Willamette Rivers. Major General Wesley G. Peel, Division Engineer of the North Pacific Division, looked to the future in declaring that "maintaining the channel in the proper manner will require the same kind of dedication and cooperation shown in its construction."<sup>41</sup>

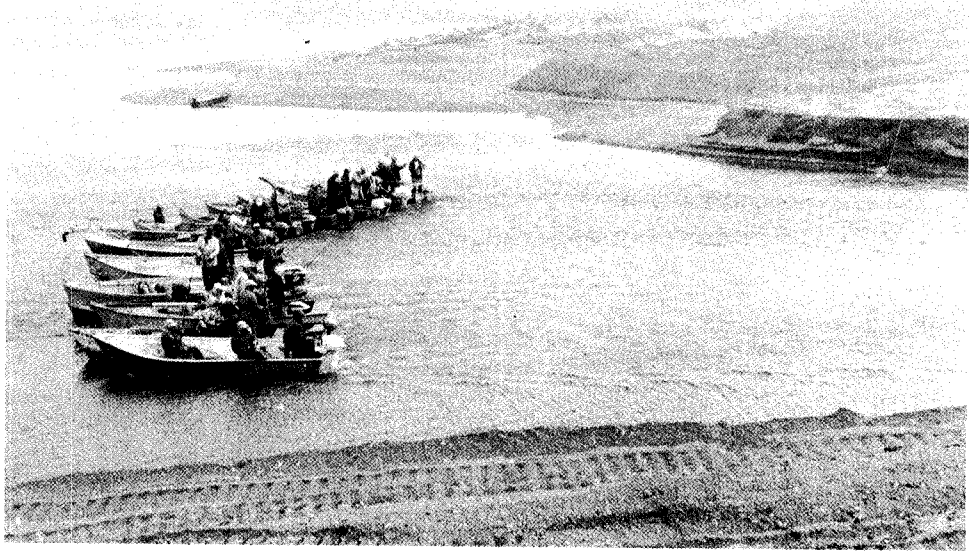
The quiet and unspectacular work on the 115-mile, 600-foot-wide dredging project, although lacking the drama of the dangerous work of earlier days, proved indispensable to regional economic development. In anticipation of its completion, shippers and commercial interests had made numerous investments related to port development all along the Columbia and Snake River systems as far as Lewiston, Idaho, 465 miles from Astoria. The continued growth of the flourishing barge traffic above Portland also depended upon the huge ocean-going vessels to carry the commerce of the Inland Empire from Portland to the ports of the world. By 1976, traffic through the lower Columbia ship channel reached 42 million tons, an increase of 16 million over that of 1964.<sup>42</sup>

In addition to its work on the mainstream of the Columbia, the Portland District carried out navigation improvements on the Oregon coast after 1930 at existing projects and at new locations. Commercial shippers, fishermen, and pleasure boaters all benefited from quicker, safer, and larger waterways at the rivers and bays on the Oregon coast. The Corps still maintains 15 projects from the mouth of the Columbia south to the Chetco River, a distance of 300 miles.

At the entrance to the Nehalem River, about 40 miles south of the mouth of the Columbia River, the Corps undertook a navigation improvement. In combination with private interests, the Corps of Engineers completed two jetties 4,950 and 3,850 feet long in 1918 at a total cost of about \$640,000. Ten miles below the Nehalem River, the Portland District carried out work at Tillamook Bay. Beginning with pile dike construction in 1888, the Corps ultimately completed in 1933 a 5,700-foot jetty on the north side of the entrance. At Garibaldi on the north end of Tillamook Bay, the Corps completed a 12-foot deep small-boat basin. In 1965, Congress authorized an 8,000-foot jetty on the south side of the entrance to achieve an 18-foot deep, 200-wide opening over the bar. The Portland District conducted the work in installments over a ten-year period, finishing in 1979. In order to protect the entrance channel, the Corps also built a 1.4-mile sand and rockfill dike to close a breach in Bayocean Peninsula in 1956. Lumber and fishing interests benefited from the improvements at Tillamook Bay.<sup>43</sup>

Depoe Bay, a small inlet 100 miles south of the Columbia's mouth, has an important charter fishing industry. Work over the years by the Corps has provided a very good small boat harbor for this enterprise. Congress authorized initial construction in 1937 and ordered modifications in 1945. This project included a breakwater north of the entrance, an entrance channel eight feet deep and 50 feet wide, and an inner basin with a retaining wall built on the east side of the bay. The Portland District completed the original work in 1952 and built a second breakwater in 1966.<sup>44</sup>

One of the earliest Portland District navigation projects on the Oregon coast exists at Yaquina Bay. The district started the two Yaquina jetties in 1880 and completed them in 1896. A Board of Engineers decided in 1900 that no further improvement could be justified at that time. In 1919, Congress authorized further work, including restoration of the jetties,

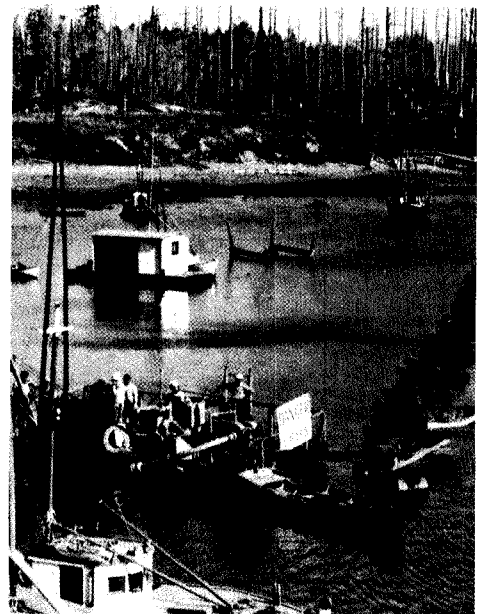


*Sports fishermen.*



*right: Commercial fishing boats at dock in Yaquina Bay.*

*far right: Early pipeline dredge in Depoe Bay.*

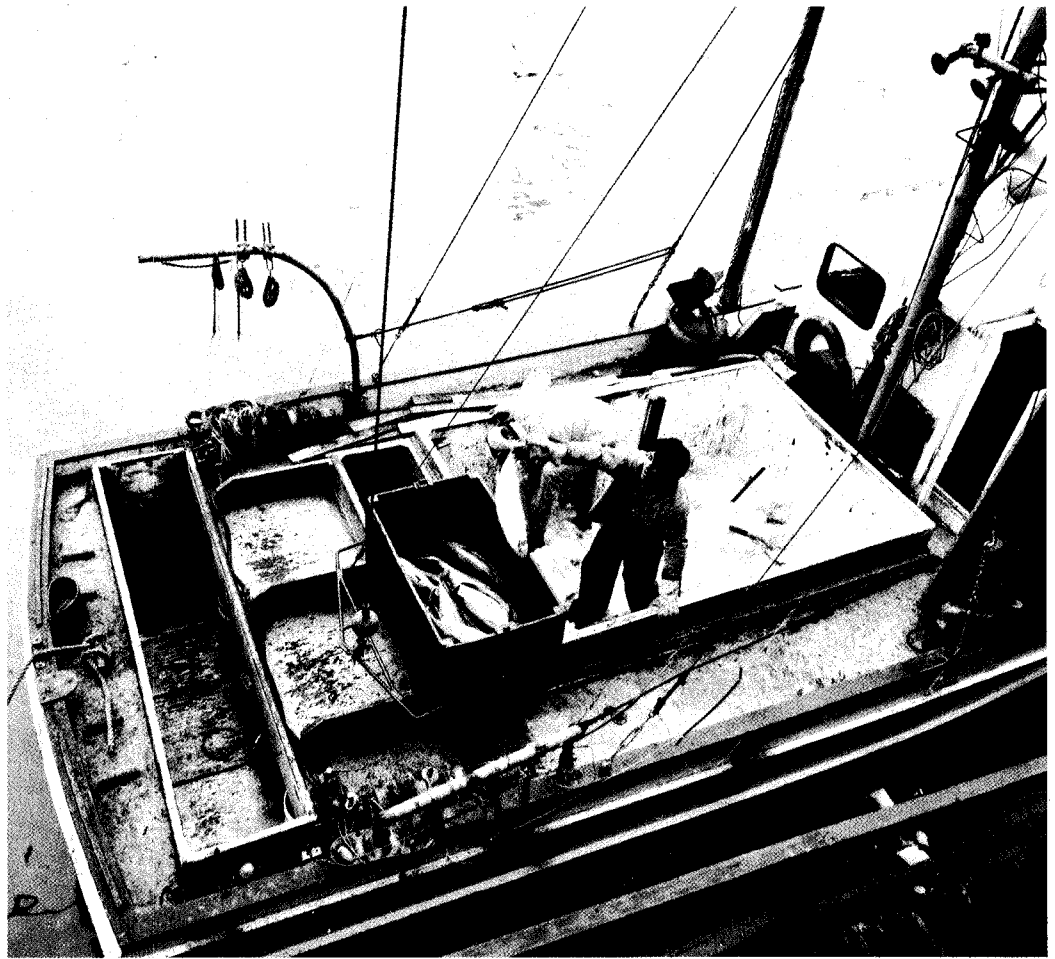


removal of the rock at the entrance, and dredging in the bay 4.5 miles to the current railroad terminus at Yaquina. Legislation in 1937, 1945, and 1946 authorized additional improvements. The 1937 River and Harbor Act, the most important of the three, permitted extension of the north jetty to a length of 4,700 feet and the south jetty to 5,800 feet. The Act also called for an 800-foot spur jetty off the south jetty near its land end and for five groins channelward from the original structure. The work would provide an entrance channel 26 feet deep, a two-mile inner passage 20 feet deep and 300 feet wide, a turning basin, and a 4.5-mile channel from Newport Docks to Yaquina 18 feet deep and 200 feet wide. The 1946 River and Harbor Act authorized a small boat basin behind a 2,650-foot breakwater at the north end of Yaquina Bay at Newport. The Portland District finished all of the work included in the three river and harbor acts by 1952.<sup>45</sup>

From a population of 500 in 1900, Newport had grown to about 6,000 by 1958. To provide adequate navigation facilities for the lumber and fishing industry of the area, the 1958 River and Harbor Act authorized extending the north jetty to a length of 6,500 feet and the south jetty to 7,600 feet in order to produce 40 feet of safe water over the bar and 30 feet in the channel leading into Yaquina Bay. The project called for widening the entrance and lengthening the previously constructed turning basin. Completing surveys in 1963, the Portland District finished the repair and extension of the north jetty in 1966 and extended the south jetty during 1971-72. The Portland District has maintained a ten-foot channel about ten miles up the Yaquina River by annual dredging since 1914.<sup>46</sup>

The Siuslaw River empties into the Pacific Ocean 154 miles south of the mouth of the Columbia. Portland District's early jetty project, completed in 1917, provided eight feet of

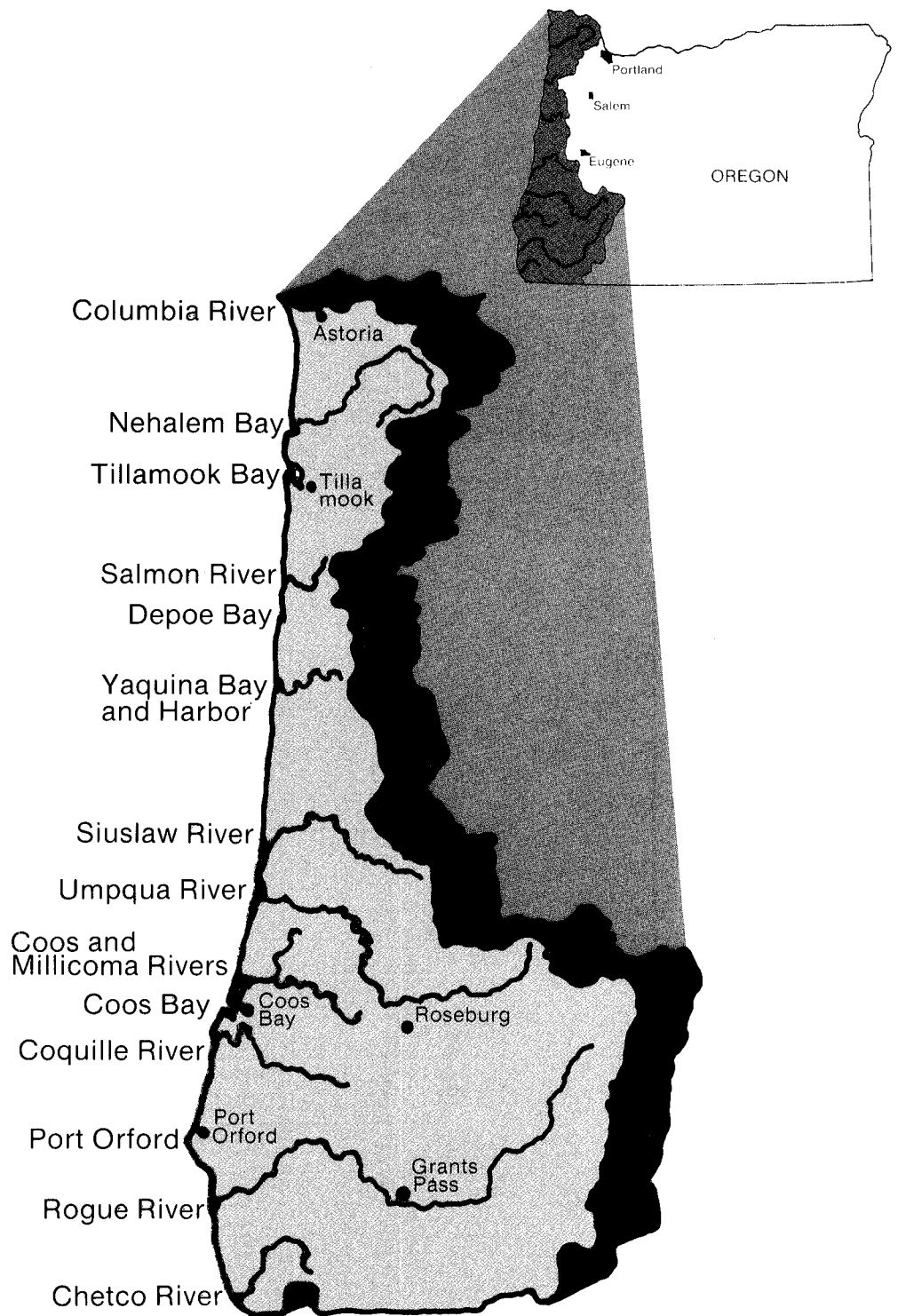
*Commercial fishing boat  
unloading catch at  
processing plant dock on  
Yaquina Bay waterfront.*



safe water at the entrance. River work, finished in 1930, secured a channel upriver two miles above Florence. The Corps rehabilitated the outer 1,700 feet of the north jetty in 1957-58 and the south jetty in 1962. In 1958, the River and Harbor Act authorized a depth of 18 feet over the bar and 16 feet in the river channel. The act further set a width of 300 feet at the bar and 200 feet throughout the channel for a distance of seven miles upstream. The legislation also authorized construction of a turning basin opposite Siuslaw Dock in Florence. Lumber and plywood shippers, commercial fishermen, and pleasure boaters have been the principal users of the improved waterway. The Corps accomplished the improvements by extending the north jetty 600 feet and by increased dredging. While the district finished the dredging in 1969, it deferred the proposed extension of the north jetty pending further studies of the entire jetty system. During 1975, the Corps dredged a 12-foot deep channel from Cushman to near Mapleton on the river.<sup>47</sup>

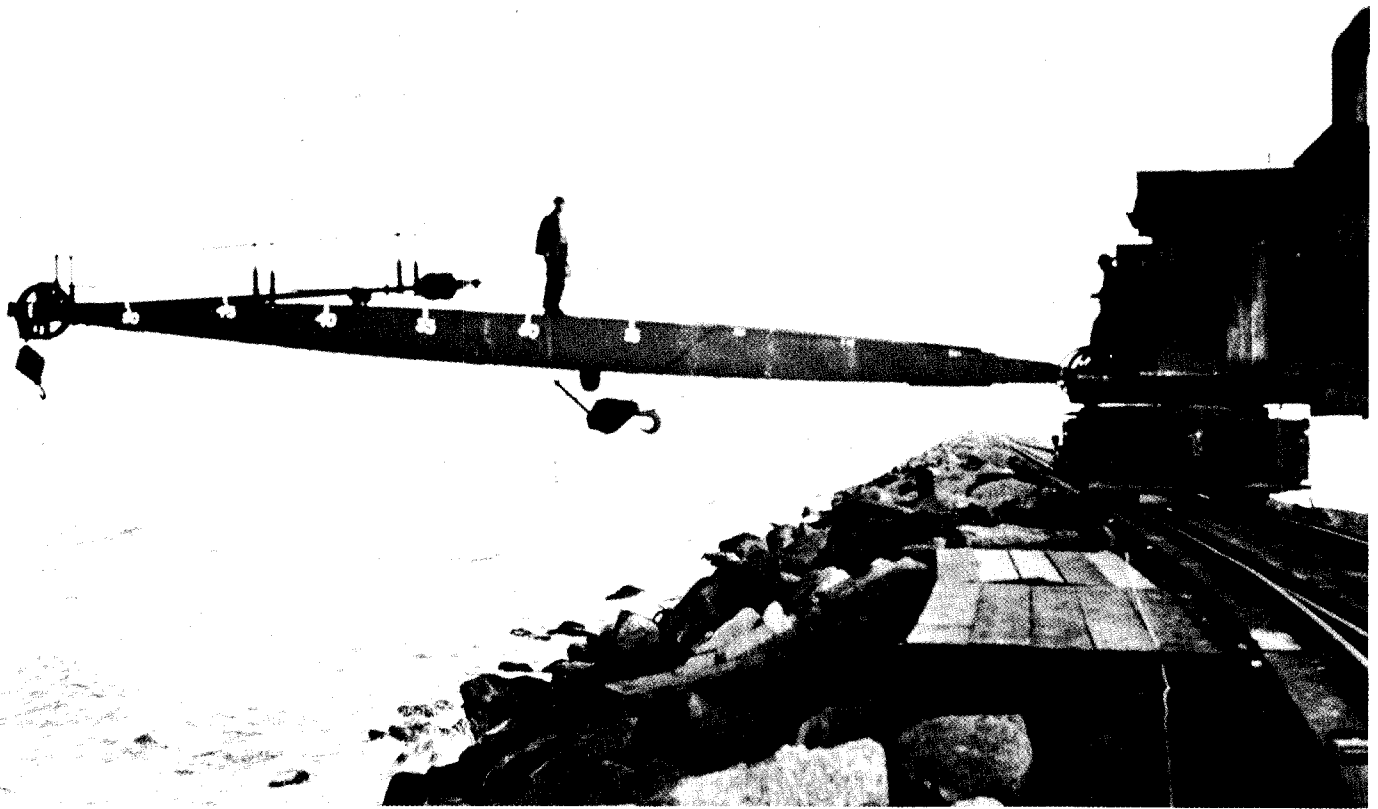
The mouth of the Umpqua River, near the town of Reedsport, Oregon, is 180 miles south of the mouth of the Columbia. Navigation on the Umpqua attained early importance because of the gold rush in southern Oregon during the 1850s. Merchants shipped mining supplies from California 30 miles up the Umpqua to the distribution point of Scottsburg. The government built the first lighthouse on the Oregon coast at the mouth of the river in 1857. In 1871, the Corps of Engineers spent \$22,500 on channel work to make the river navigable for light-draft steamers between Scottsburg and Roseburg at the southern end of the Willamette Valley, a distance of 70 miles. No steamboat company made use of the improvement and Major Robert recommended against further work. Over the next 50 years, Robert's successors carried out small rock removal projects to deepen the channel between Scottsburg and the mouth of the river for light-draft vessels.

The first structural improvement on the Umpqua involved an 8,000-foot jetty on the north side of the mouth authorized in the River and Harbor Act of 1922. The Portland District completed the north jetty in 1930 by the tramway-and-dumped-stone method of construction. In 1930 and 1935, Congress approved a 4,200-foot south jetty, extending to a point 1,800 feet south of the north jetty. The Corps completed the original south jetty in 1933 and an extension in 1938. The 1935 act provided for dredging to a depth to 26 feet at the bar, and the River and Harbor Act of 1938 authorized a 22-foot deep and 200-foot wide channel from the entrance 11 miles up the river to Reedsport. This work, completed in 1941, benefited the large lumber mills located at Reedsport and Gardiner.<sup>48</sup>

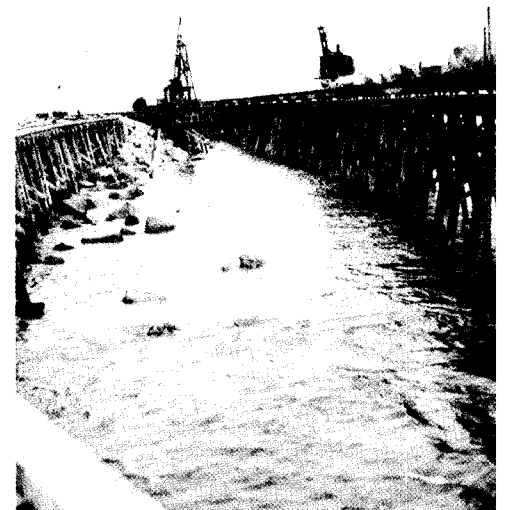
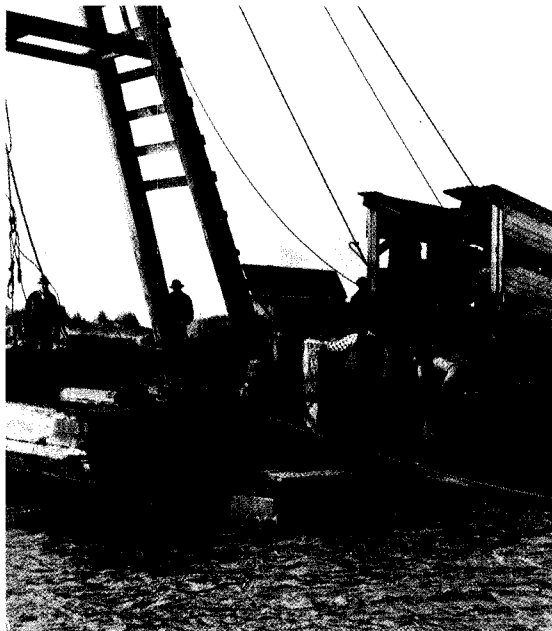


*Map of Oregon coast harbors  
and rivers maintained by  
Portland District.*

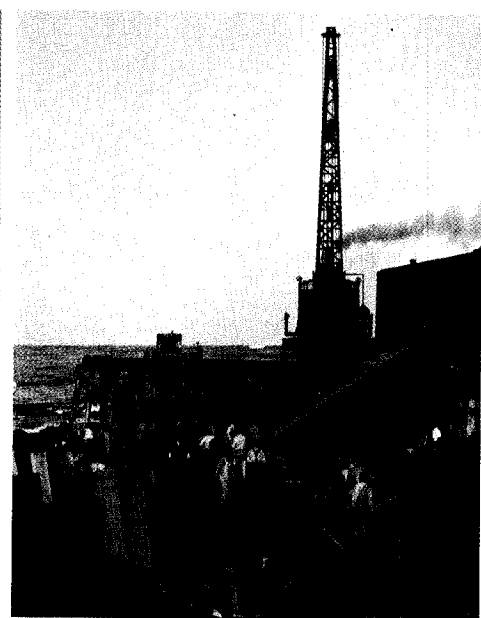
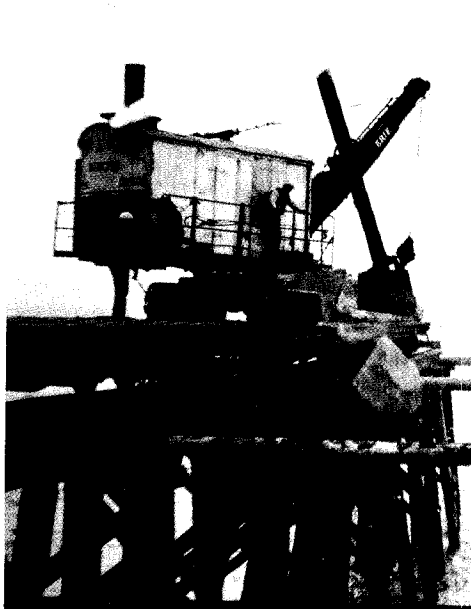
In 1942, the district rehabilitated the north jetty. The seas had beaten down the outer 800 feet, submerging it at high tide. The Corps also deepened, in 1949, the channel leading to Gardiner and enlarged a turning basin opposite the town. By 1956, the district had performed similar work from the main channel to Winchester Bay, two miles above the mouth on the south side of the Umpqua. By the late 1940s rough seas had partially destroyed the south jetty. To supplement it, the Corps constructed a 5,500-foot long training jetty parallel to the entrance of the river in 1951. The south jetty received rehabilitation in 1963. Starting in 1979, work began on a 2,600-foot extension of the training jetty to connect it with the tip of the south jetty. The engineers designed the extension to control the dangerous cross currents caused by the angle between the north and south jetties. Sand, gravel, and rafted logs constituted most of the tonnage on the Umpqua River.<sup>49</sup>



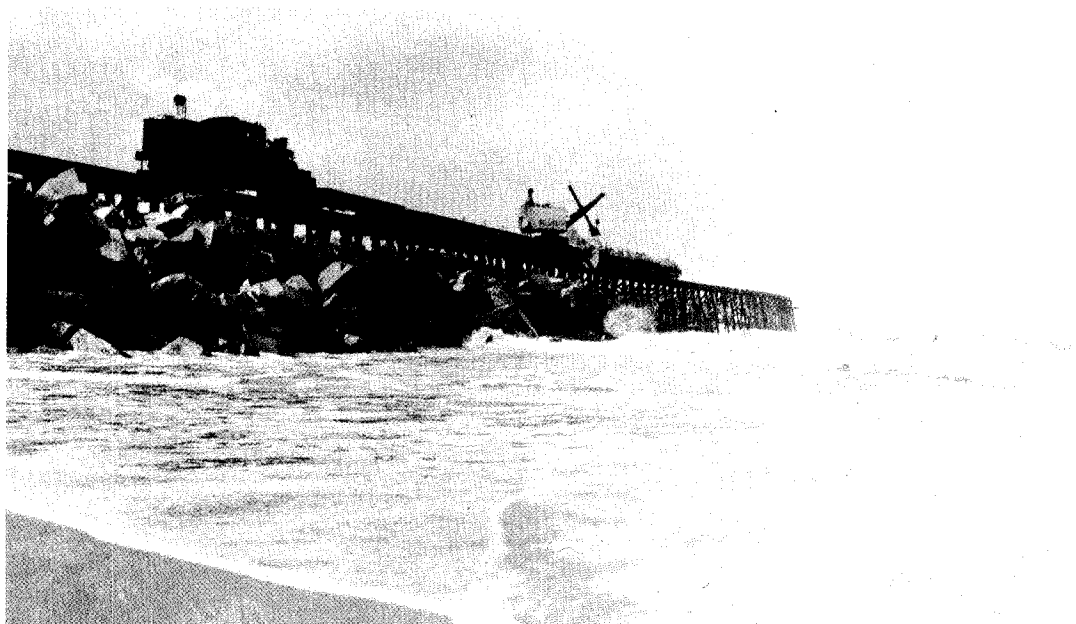
above: Crane used to place  
jetty stones, right: Driving  
piles for jetty tramway, far  
right: View down tramway as  
rock dumping begins.



Coos Bay, 200 miles down the coast from the mouth of the Columbia River, is the most important port on the Oregon seashore. It is also the largest forest-product exporting port in the world. Its lumber industry depended upon utilization and inexpensive shipment of the various products derived from the extensive stands of timber located in the area. Developing this potential required improving the bay for deep draft ships. The Portland District began its first work at Coos Bay in 1879. This project called for a half-tide jetty inside the entrance to attain a deeper and straighter channel across the bar. Congress altered the project in 1890 to include two jetties at the entrance. The district completed work on them in 1929 and dredged the main channel to 24 feet by 1937. It reconstructed both jetties in 1940 and 1942, adding a concrete cap for the entire length of the south structure.<sup>50</sup>



top left: Jetty rock quarry, top  
right: Smaller rock on  
tramway car before trip to  
dumping area.  
center left and middle: Crane  
lifts and dumps stone, center  
right: Concrete cap put on  
end of jetty.  
lower right: Jetty progresses  
from beach.





*The harbor area at Coos Bay*

The River and Harbor Act of 1946 increased all project dimensions at Coos Bay. A dredging project completed in 1952 increased the depth over the entrance bar to 40 feet, decreasing to 30 feet at Guano Rock about one mile inside the entrance. The Corps deepened the navigation channel from Guano Rock to 30 feet, with a 300-foot width for a distance of 15 miles, and enlarged several turning basins. Work on the channel and the basins was completed in 1951. The engineers built a 10-foot deep, 150-foot wide channel from the main channel to Charleston in 1956, together with a small boat basin. The south jetty received rehabilitation in 1963 and repairs to the north jetty, together with a channel extension in the South Slough, were carried out in 1970. This work increased project depths by five feet at the entrance and in the main channel to 45 and 35 feet respectively. The improvement permitted average annual tonnage, chiefly in wood products, of 6.8 million between 1968 and 1977.<sup>51</sup>

A Corps project, consisting of snagging and boulder removal, had maintained a three-foot depth on the Coos and Millicoma rivers for a distance of 13 miles upstream from Coos Bay between 1899 and 1948. In the latter year, the River and Harbor Act authorized increasing the depth of about two-thirds of the project to five feet. The Corps accomplished this improvement by 1966. The work facilitated log movement in an area poorly served by roads.<sup>52</sup>

The Coquille River flows into the Pacific Ocean at Bandon, Oregon, 225 miles south of the mouth of the Columbia River. Long-standing projects initiated in 1880 and completed in 1908, provided a safe entrance by two high tide jetties and dredging. The River and Harbor Act of March 1945 authorized snagging on the Coquille River to the town of Coquille, about 24 miles from the mouth. The Corps reconstructed the north jetty in 1942 and added a 750-foot extension to its easterly end in 1951. The south jetty received repairs in 1954 and the north jetty in 1956.<sup>53</sup>

Port Orford lies about 250 miles south of the mouth of the Columbia River. Engineers in charge of the Portland office recognized early Port Orford's potential as a harbor of refuge. The natural deep-water entrance at Port Orford enjoyed a fairly central location between Northwest ports and California. The harbor was an open roadstead protected from the north and west by a bold headland 300 feet high, extending seaward for about a mile. However, on the south, it provided no protection from severe storms. Between 1873 and 1898, seven separate studies explored the possibilities of improving the harbor, but all failed



*above: Port Orford in the  
early 1900s.*

*right: Today, Port Orford is  
still an Oregon Coast  
highlight.*



to win final approval because of the high cost involved and the absence of commercial development at the location. In time, local interests built a short breakwater to protect shore installations and craft from winter storms. This work afforded only limited aid, for piers and wharves originally built in 1934 had to be reconstructed five times following nearly complete destruction by winter storms from the southwest. Finally, in 1965, Congress authorized the Corps of Engineers to extend the privately constructed breakwater by 550 feet. The Portland District completed the extension in October 1968 at a cost of \$758,692.<sup>54</sup>

The Rogue River rises in the Cascade Range in southwestern Oregon, flows westward through the Coast Range, and empties into the Pacific Ocean 264 miles south of the Columbia's entrance. The River and Harbor Act of 1954 provided for the improvement of the Rogue River at Gold Beach by construction of two jetties at the entrance and a channel 13 feet deep and 300 feet wide leading from the ocean to a turning basin just below the U.S. Highway 101 bridge. The Corps finished work on the south jetty in October 1959 and the north jetty in September 1960, placing 680,000 tons of stone in the structures. By October 1961, the Engineers had dredged the channel, a turning basin, and the entrance bar. A major flood in 1964 damaged the north jetty, necessitating repair work which was completed in 1966. The Corps performed bank protection work at the mouth of the Rogue River in 1971 and 1972. Local interests sought this improvement to encourage the growth of their timber and fishing industry and to create a harbor of refuge for barges and tugs.<sup>55</sup>

The tenth project undertaken by the Portland District on the Oregon coast occurred at the mouth of the Chetco River at Brookings. The Chetco River joins the ocean about ten

right: Mouth of the Rogue River, below: Sign at Rogue River jetty.



above: Chetco River near mouth.

miles north of the California border. The River and Harbor Act of 1945 permitted construction of two small jetties at the entrance of the Chetco. The Portland District built these structures by 1957 and removed obstructions in the waterway in 1959. The Corps repaired the south jetty in 1962.<sup>56</sup>

The 1965 River and Harbor modified the project by authorizing a 450-foot extension to the north jetty and increasing its elevation. The Corps designed this work to produce depths of 14 feet and a width of 120 feet. The improvement also called for a barge turning basin. Local interests furnished a small boat basin, barge slip, and spoil deposit areas. The Corps finished work on the north jetty and dredging of the entrance channel in 1969 and constructed the turning basin, small boat access channel, and protective dike in 1970. The improvement of the Chetco benefited the small lumber and commercial fishing industry of the area.<sup>57</sup>

The Portland District has undertaken numerous minor navigation improvements along the Oregon coast as well. Two examples of such small projects took place on the Salmon and Smith Rivers. The mouth of the Salmon River is located at Cascade Head, south of Neskowin. The River and Harbor Act of 1945 provided for the removal of dangerous rocks just inside the mouth of the river. This work provided a much needed refuge for small fishing and recreational craft along that section of the coast. The Smith River empties into the Umpqua River 11 miles from its mouth at Reedsport. Work on the Smith River, authorized by Congress in 1948, created a navigation channel six feet deep and 100 feet wide from the mouth for a distance of 16 miles, then four feet deep and 75 feet wide for another

five miles. The project also included a passing basin at the 16-mile point. The Corps completed the work in six months during 1957. The Smith River improvement aided the movement of logs to lumber mills at Reedsport and Gardiner and assisted settlers along the river, who depended on it to transport their produce to market and to receive their mail.<sup>58</sup>

Navigational improvements along the Oregon coast have been essential to the economic development of the region and have required constant attention from the Corps. Annual flooding caused estuaries to fill with sediment, requiring continual dredging; while wave damage necessitated periodic rebuilding of jetties. As Table I indicates, the Portland District spent over \$99 million on constructing the coastal projects and more than \$89 million maintaining them through 1980. This investment helped sustain the wood products and fishing economy of the area.

**Table I**  
**U.S. Army Corps of Engineers**  
**Coastal Projects**

Project	Cost to 1980	Maintenance to 1980	Rehabilitation to 1980
Chetco	\$ 2,043,713	\$ 1,950,428	\$
Coos Bay	29,750,092	38,544,245	2,335,966
Coos and Millcoma Rivers	350,238	984,613	
Coquille River	693,366	3,249,951	
Depoe Bay	367,364	420,938	
Nehalem Bay	302,006	44,760	156,584
Port Orford	758,692	1,011,923	
Rogue River Harbor	4,156,252	4,227,370	635,783
Siuslaw River	1,159,357	6,001,462	879,285
Tillamook Bay	22,434,827	2,253,212	2,839,799
Umpqua River	17,847,871	16,744,731	2,500,677
Yaquina Bay	19,242,046	13,316,085	
Yaquina River	28,800	569,187	